Regional Stratification and Shear of the Various Streams Feeding the Philippine Straits – ESR Component

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LONG-TERM GOALS

To determine the impact of the time-varying regional oceanographic and atmospheric conditions on the Philippine Archipelago strait dynamics and basin-wide ocean-atmosphere interaction and mixing.

OBJECTIVES

To identify the oceanographic stratification and shear conditions during different monsoon and inter-annual time periods within the Philippine Archipelago region in order to quantify the time and spatial variability and the connection to larger-scale processes. To assess the role of precipitation on providing stabilizing buoyancy to the ocean surface, in order to assess the potential impact on smaller-scale oceanic processes.

APPROACH

Regional CTD and Lowered ADCP observations analyzed within the context of global data sets.

WORK COMPLETED

Data acquisition and analysis on the Philippine Archipelago region with global satellite data, rain and tide gauge data, and the June 2007 Philippine Exploratory Cruise and February 2008 Regional Cruise CTD and LADCP observations.

RESULTS

The February 2008 Regional Cruise (Figure 1, left panel) and the June 2007 Exploratory Cruise (Figure 1, right panel) were carried out in opposing seasons successfully capturing the monsoonal range in ocean surface conditions with cool temperatures (~27.5°C) in February and warm temperatures (~30.0°C) in June. Relative to the 1982 to 2008 SST means in the Philippines region, both February 2008 and June 2007 were about 0.5°C anomalously warm.

The upper-layer salinities observed during the two cruises also reveal monsoonal contrasts. During the February 2008 Regional Cruise (Figure 3, left panel) surface salinities are mostly fresher then 33.9, whereas during the June 2007 Exploratory Cruise (Figure 3, right panel) they are mostly saltier then 33.9. Land precipitation data reveals that the February 2008 surface salinities may be significantly

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14. ABSTRACT
To determine the impact of the time-varying regional oceanographic and atmospheric conditions on the Philippine Archipelago strait dynamics and basin-wide ocean-atmosphere interaction and mixing.

15. SUBJECT TERMS

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anomalous. Monthly weather station precipitation data (Figure 4) for Tacloban, Philippine (11.2 N, 125 E) reveals extraordinary wet conditions during the February 2008 Regional Cruise, whereas rainfall conditions were typical during the June 2007 Exploratory Cruise.

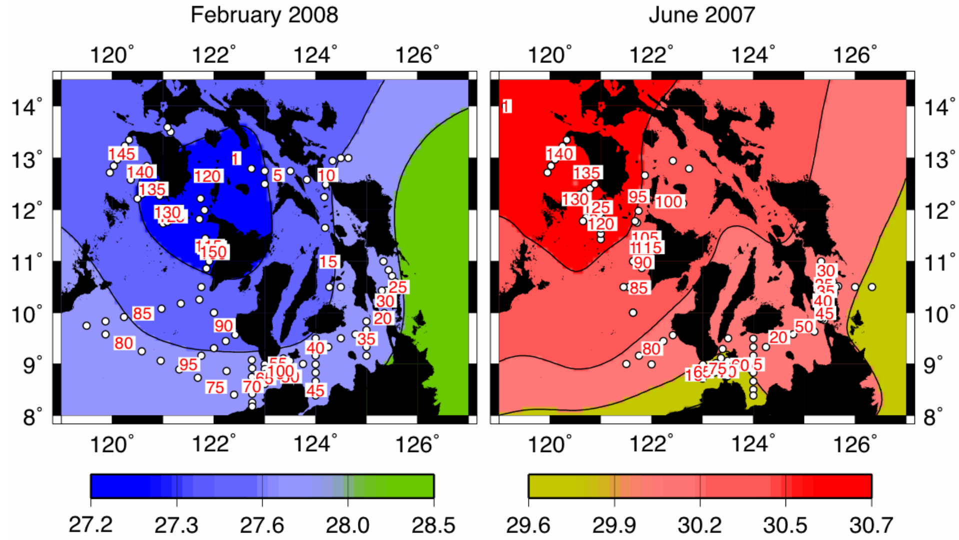

Figure 1. The station locations for the February 2008 Regional Cruise (left panel) and the June 2007 Exploratory Cruise (right panel). The OI satellite product SST is also shown on the maps revealing the overall cool conditions in February in contrast to the overall warm conditions in June.

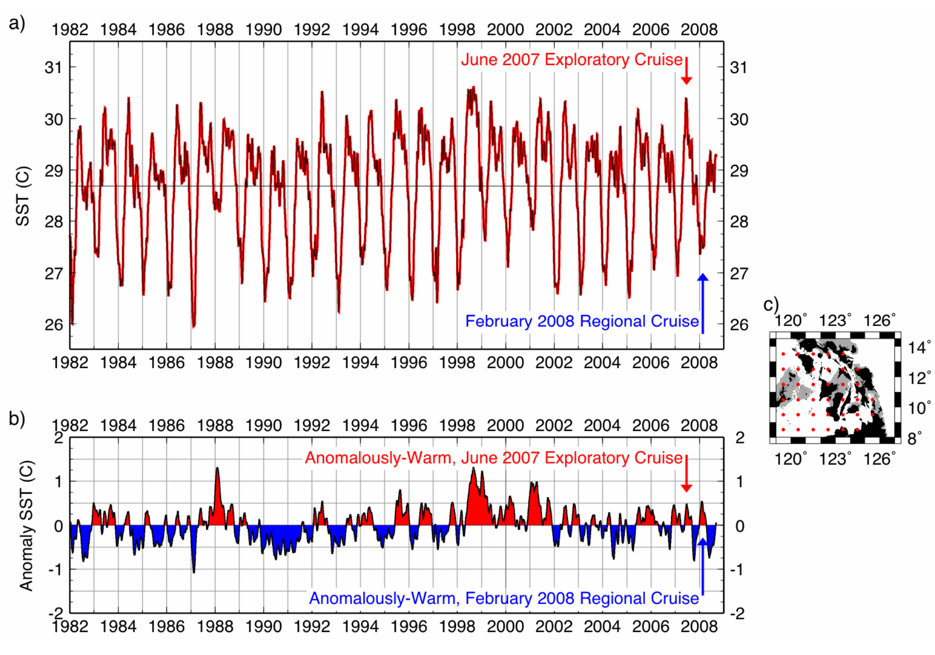

Figure 2. The OI satellite product SST time series for the Philippine region revealing in a) the warm summer SST conditions during the June 2007 Exploratory Cruise and the cool winter SST conditions during the February 2008 Regional Cruise, in b) the about 0.5℃ anomalously warm SSTs during both June and February relative to the 1982 to 2008 means, and in c) the location of the data.

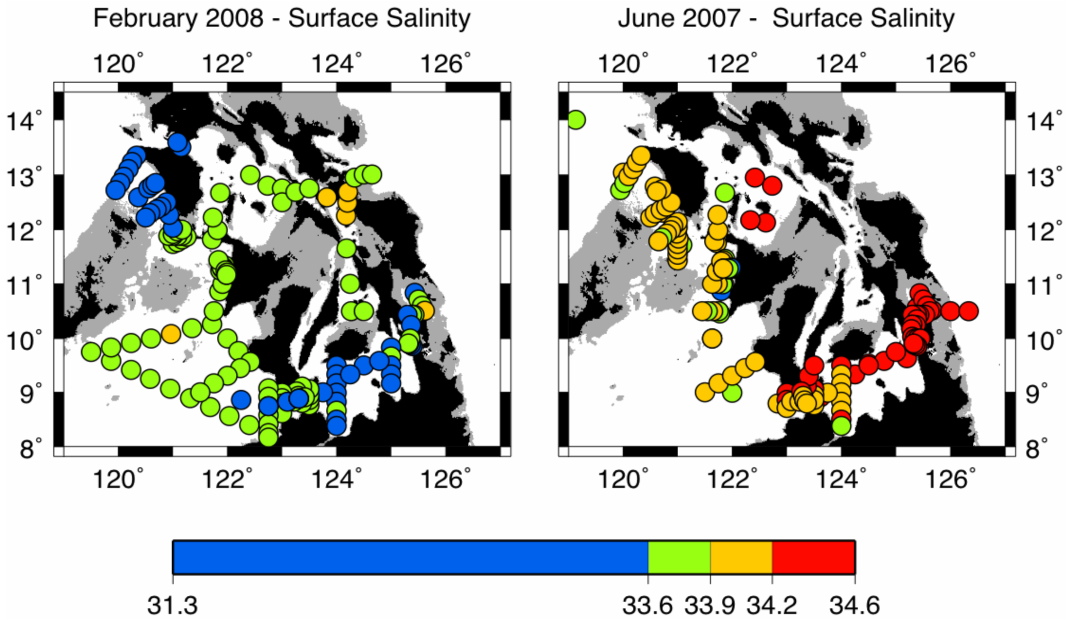

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Figure 3. The February 2008 surface salinities (left panel) are mostly fresher then 33.9, whereas the June 2007 surface salinities (right panel) are mostly saltier then 33.9. The salinity values are from the CTD profiles, and the 100 m ocean bathymetry is shaded grey.

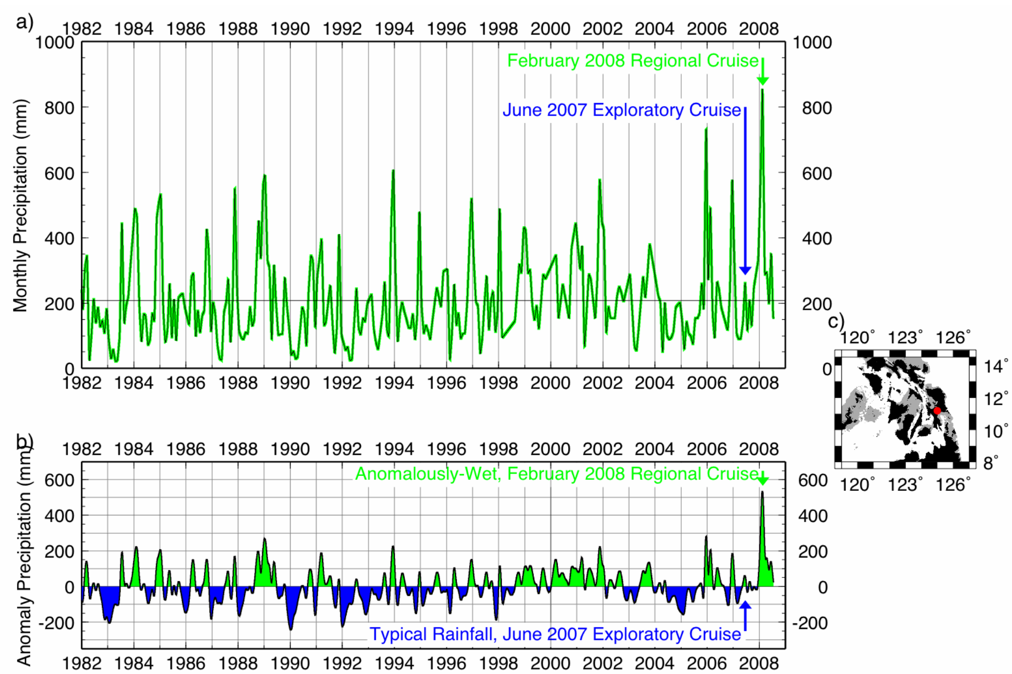

Figure 4. Monthly weather station precipitation data from the Global Historical Climate Network (NOAA NCDC GHCN beta version 2) for Tacloban, Philippine (11.2 N, 125 E) revealing in both a) the time series, and in b) the time series anomaly, the extraordinary wet conditions during the February 2008 Regional Cruise, whereas rainfall conditions were typical during the June 2007 Exploratory Cruise. Note there are data gaps, e.g. in early 1998 and late 1999. The location of the rain station is shown in c).

The CTD profile data show the potential dynamical significance of the freshwater on the upper-layer ocean. The difference between the colder upper-layer temperatures in February 2008 (Figure 5a, blue) and the warmer temperatures in June 2007 (red) persist down to about 150 db on average. The difference between the fresh upper-layer salinities in February 2008 (Figure 5b, blue) and the higher salinities in June 2007 (red) persist down to about 120 db on average. However, in each season the salinities are compensating against the temperature effect in density, with fresh conditions in February 2008 diminishing the destabilizing effect of the cool surface temperatures, and in June 2007 the higher salinities diminishing the stabilizing effect of the warm surface temperatures. The net effect is that the upper-layer density (sigma theta) profiles are not all that different between the two seasons (Figure 5c).

The role of the fresh water in February 2008 can be assessed by hypothetically constructing the February 2008 density profiles with all salinity values equal to 34.5, revealing the freshwater effect on density to be about 0.5 kg/m3. Therefore, without the considerable freshwater during February 2008, the upper water column would have been significantly less stable. This suggests that more typical rainfall in February, or even drought conditions associated with El Nino, would produce saltier surface salinities working in concert with the cold winter temperatures to produce a less-stable upper water column impacting all upper-layer dynamical processes.

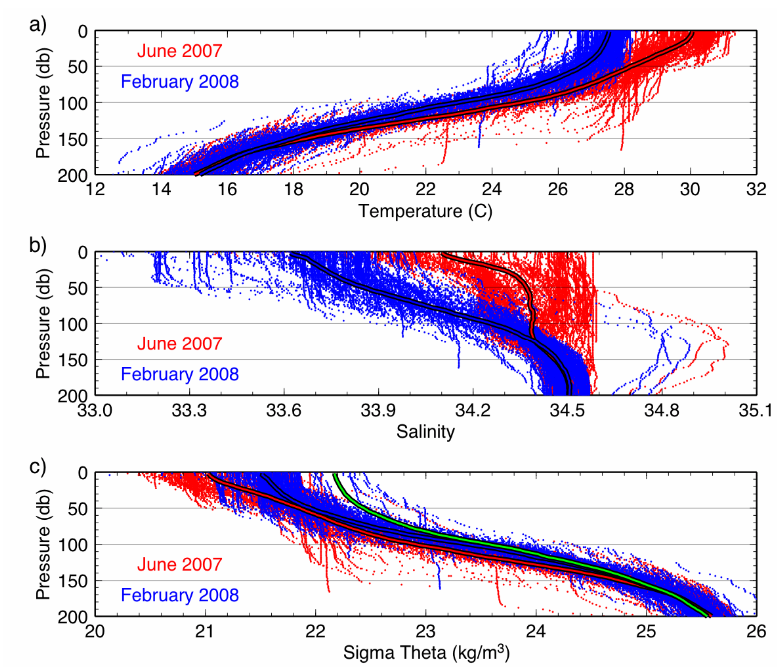

Figure 5. The upper-layer temperature (a), salinity (b), and sigma theta (c) profiles (dots) and profile-averages (solid lines) for the February 2008 Regional Cruise (blue) and the June 2007 Exploratory Cruise (red). Colder upper-layer temperatures (a) are expected in February 2008 and warmer temperatures in June 2007. However, the strong contrast in upper-layer salinities (b), with low-salinities in February 2008 and high-salinities in June 2007, compensate against the temperature effect in density: In c) the upper-layer sigma theta profiles are not all that different between June 2007 and February 2008 despite the contrasting temperatures and salinities. The role of the low-salinities in February 2008 can be assessed by hypothetically constructing the February 2008 density profiles with all salinity values equal to 34.5 (solid green line), revealing the freshwater effect on density to be about 0.5 kg/m3. The data are from the CTD profiles.

Using the CTD profiles, the upper-layer average Brunt-Vaisala frequency (Figure 6) for February 2008 (left panel) are mostly less then 8 cph, whereas for June 2007 (right panel) they are mostly higher then 8 cph, with the exception of the Surigao Strait (~125.5 E, ~10 N). These monsoonal contrasts are consistent with the monsoonal differences in density observed in the profiles (Figure 5c), and indicate a general uniformity to the regional pattern. The departure from this regional pattern is most significant at the Surigao Strait; the speed sections highlight in both seasons the obvious high speeds in the vicinity of the Suriago Strait (Figure 7: stations ~20-30, and Figure 8: stations ~30-40; lower panels) and the density section shows a well-mixed water column in the vicinity of the Suriago Strait in June 2007 (Figure 8: stations ~30-40; upper panel), which leads to the observed low Brunt-Vaisala frequencies.

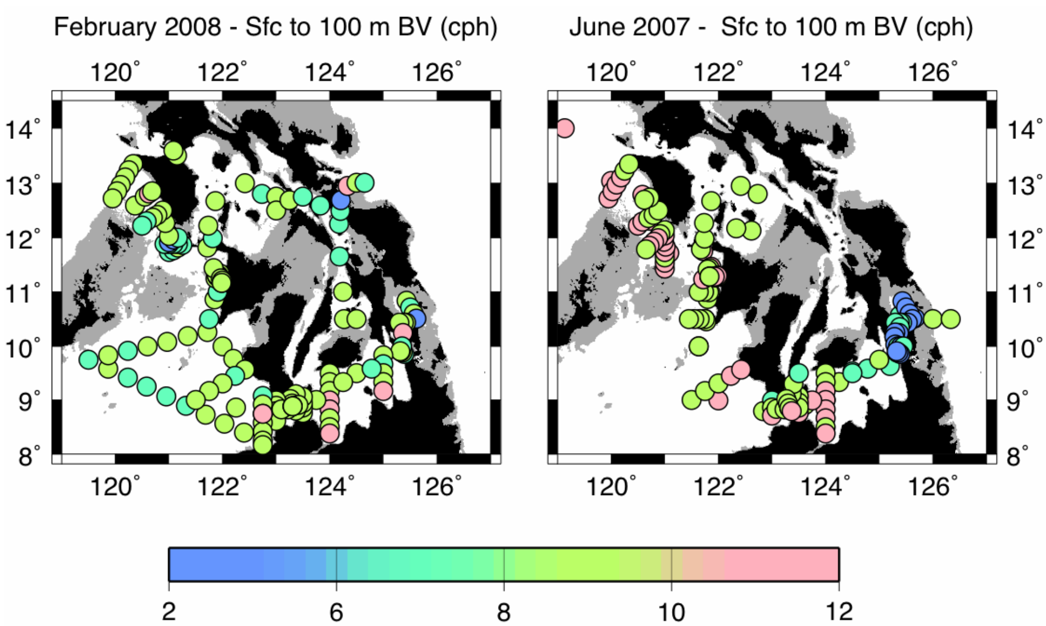

Figure 6. The February 2008 Brunt-Vaisala frequency (left panel) are mostly less then 8 cph, whereas the June 2007 Brunt-Vaisala frequency(right panel) are mostly higher then 8 cph, with the exception of the Surigao Strait (~125.5 E, ~10 N). The Brunt-Vaisala frequency values are determined from the CTD profiles, and the 100 m ocean bathymetry is shaded grey.

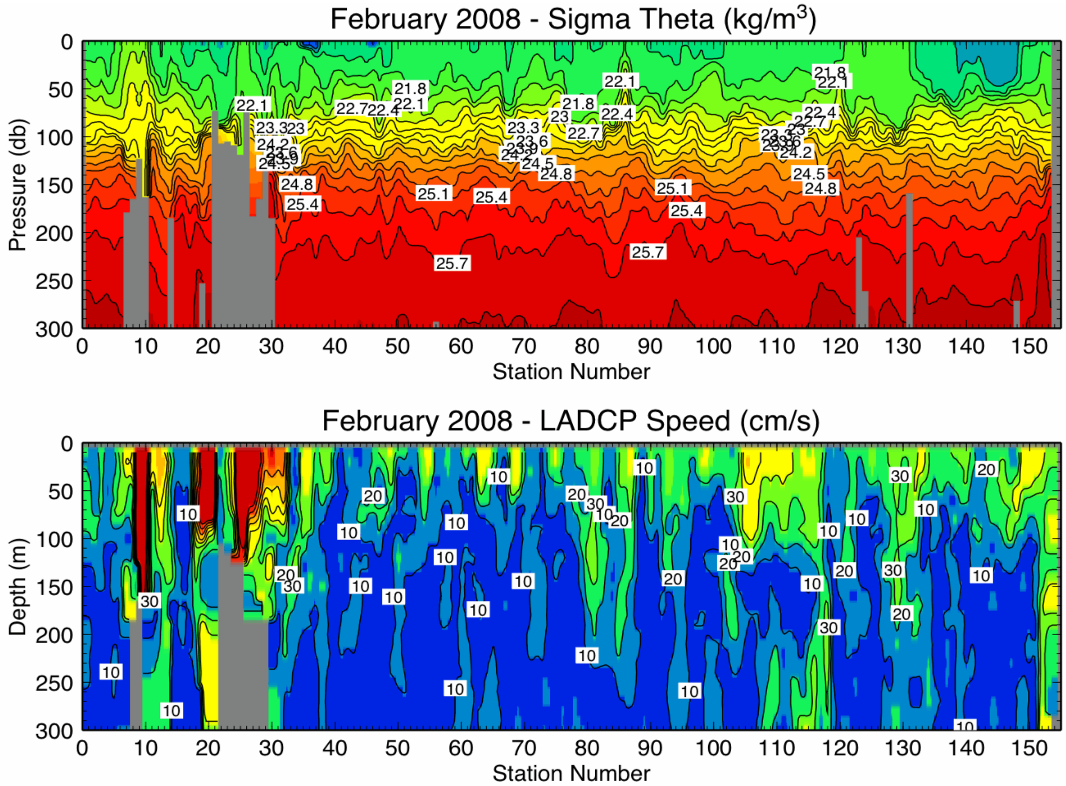

Figure 7. The February 2008 sigma theta section (top panel) and LADCP speed section (lower panel). The locations of the stations are shown in Figure 1.

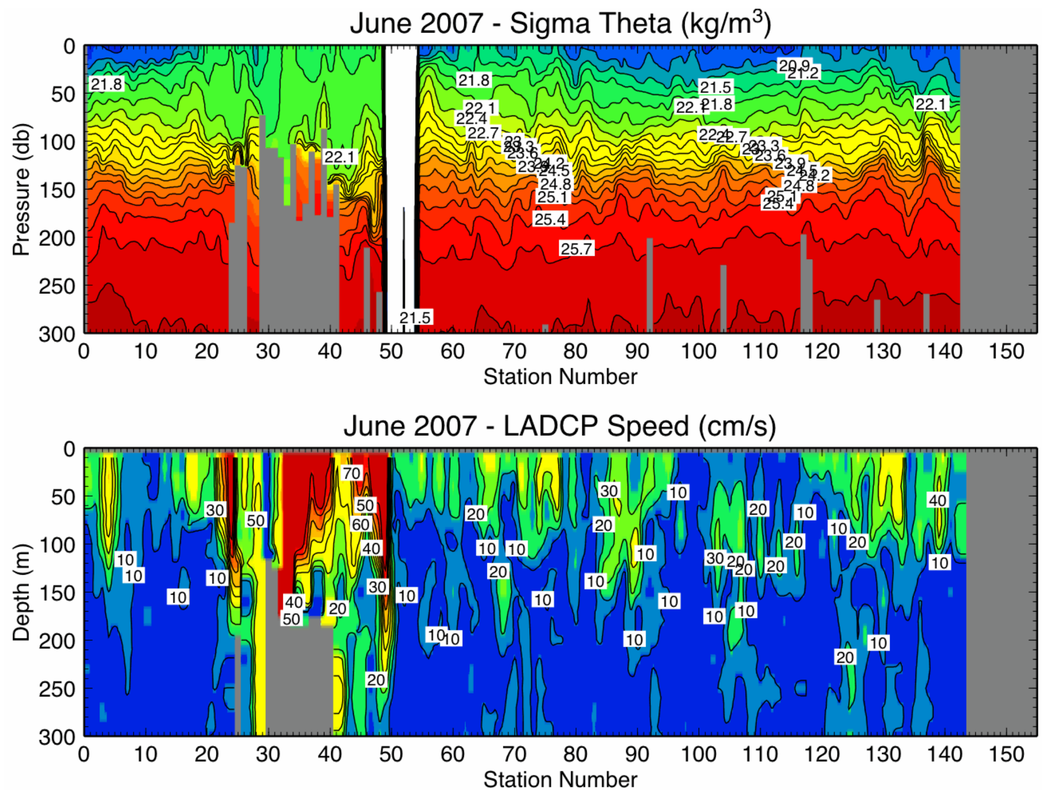

Figure 8. The June 2007 sigma theta section (top panel) and LADCP speed section (lower panel). The locations of the stations are shown in Figure 1.

IMPACT/APPLICATIONS

The larger-scale stratification and shear of the water column throughout the Philippine region reveal the boundary conditions that can impact strait dynamics. The exceptionally fresh ocean surface conditions observed during the February 2008 Regional Cruise are important in controlling the stability of the upper water column, as they add significant buoyancy diminishing the destabilizing effect of the cold winter surface temperatures. These fresh February 2008 conditions, associated with very high rainfall during that time, are hypothesized to be anomalous on both monsoonal and inter-annual time scales. This would suggest that more typical rainfall, or even drought conditions associated with El Nino, would produce saltier surface salinities working in concert with the cold winter temperatures to produce a less-stable upper water column impacting all upper-layer dynamical processes.

RELATED PROJECTS

None.